COPY

KOOTENAI DEVELOPMENT IMPOUNDMENT DAM

ELEVATION AND LATITUDE/LONGITUDE LOCATION SURVEY REPORT

BILLMAYER & HAFFERMAN ENGINEERING INC.

February 11, 2010

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Signature and Statement of the Professional Engineer
for the
Kootenai Development Impoundment Dam
Elevation and Latitude/Longitude Location Survey Report
February 11, 2010

I declare that to the best of my professional knowledge and belief that I meet the definition of a Licensed Professional Engineer as defined in all of the Statutes and Rules applicable to the Board of Professional Engineers and Professional Land Surveyors as described in Title 37, Chapter 1, Part 3 in the Montana Code Annotated Uniform Regulatory Act passed by the Legislature in 1995 including all Administrative Rules pertaining to engineering and land surveying that are written and adopted by the Board of Professional Engineers and Professional Land Surveyors.

I declare that I have the specific qualifications based on education, training, and experience to assess a property of the nature, history, and setting of the subject property and that I have developed and performed the appropriate inquiries in conformance with the standards and practices.

I declare that I have personally performed a site the survey, data collection and completed this report titled the Elevation and Latitude/Longitude Location Survey Report for the Kootenai Development Impoundment Dam, know as the subject property. This assessment has revealed the conditions discussed in the attached report in connection with the property. I declare that the statements made in this report are true to the best of my belief and professional knowledge.

Kurtis M. Hafferman P.E. MT PE 10457 Date

Statement of Qualification of the Professional Engineer

Kurt Hafferman is a 1990 civil engineering graduate of Montana State University. Mr. Hafferman has over 14 years of construction experience and over 16 years as a land survey technician and is capable of recognizing existing structures, legal land locations, and past land practices. Mr. Hafferman has over 16 years of experience with the Montana Department of Natural Resources and Conservation in the Water Resources Division working on irrigation project engineering, dam safety, floodplains, and water right projects for the DNRC, all involving survey projects. Mr. Hafferman has worked as a laboratory technician for Montana State University from 1988 to 1991 and in both his positions with MSU, with the Montana DNRC, and with Billmayer & Hafferman Inc. has used and is familiar with ASTM standard testing requirements and reporting procedures.

Table of Contents

EXECTUTIVE SUMMARY

Billmayer & Hafferman Inc. (BHI) performed an elevation and latitude/longitude location survey for the Kootenai Development Impoundment Dam (KDID) in April and May of 2009. BHI contracted with Kootenai Surveyors Inc. (KSI) from Libby Montana to bring in latitude, longitude, and elevation data to two reference pins located off of the project site. Elevations from the KSI reference pins to the KDID benchmark reference point were transferred using three-wire leveling. Elevations from the KDID benchmark to the each of the individual features were conducted with a final accuracy of at least ± 0.05 ft.

The latitude/longitude location data was transferred to the KDID benchmark with a 7-second angle accuracy. The latitude/longitude location data was transferred to the drains and piezometers using a Garmin GPS 76CSx calibrated at the KDID benchmark. Drains and piezometer latitude/longitude location data is within a 5 meters (16ft.) or better accuracy.

We recommend that all of the elevation and latitude/longitude location data should be updated in the Operation and Maintenance Manual for the KDID. The corrected data should be sent to the Montana Dam Safety Program.

The dam crest elevation was corrected from 2,926 ft. to 2,927.56 ft. The box culvert and the emergency spillway elevations only changed by 0.52 and 0.08 ft. respectively. The structural height is 134.86ft., within 0.14 ft. of that previously reported.

The theoretical hydraulic capacity of the box culvert and the capacity of the emergency spillway will increase over the previously calculated capacity due to the increase in available head. As the capacity of the box culvert and the capacity of the emergency spillway far exceed the required capacity, we do not find a need to reassess the hydraulics of these structures at this time. It is not certain if the increase in crest height will change the dam breach characteristics but it is not suspected that it will. As the downstream risk is low, we recommend no action at this time but recommend that the hydraulic capacity of the spillways and the breach data be reevaluated before the next 5-year operational permit renewal deadline.

INTRODUCTION

Billmayer & Hafferman Inc. (BHI) performed an elevation and latitude/longitude location survey for the Kootenai Development Impoundment Dam (KDID) project during April and May of 2009. The following report will provide the procedure used, results, conclusions and copies of the benchmark reference data, field notes developed, maps created and a table of corrected elevation and latitude/longitude locations.

PROCEDURE

BHI contracted with Kootenai Surveyors Inc. (KSI) from Libby Montana to bring in latitude, longitude, and elevation data to an off site location. The elevation and latitude/longitude location data was transferred to the site by KSI from National Geodetic Survey (NGS) Designation J 506 Permanent Identification marker TN0688. The NGS data sheet and a map of the marker location are provided in Appendix A. The latitude/longitude location and elevation data was transferred to two rebar pins with plastic caps set in concrete adjacent to the Rainy Creek entrance road off of Highway 37. Copies of the latitude/longitude location data for the KSI reference pins and a sketch showing the approximate locations provided by KSI is also shown in Appendix A to this report.

As KSI is not HAZWOPER trained to be within the project site, a BHI survey crew, with assistance from Chapman Construction personnel, transferred the elevation and the latitude/longitude location data to the project site. A Google Earth® image of the survey route and turning points used to transfer the data from the highway to the dam site is shown in Appendix A to this report.

The elevation and latitude/longitude location data was transferred to a previously established survey pin placed on site by Sands Survey of Kalispell, Montana. The pin is located on the west side of the reservoir approximately 6 ft. from the edge of the reservoir on the east side of the access road that runs parallel to the reservoir. A Google Earth® map image showing a GPS flag at the KDID benchmark as well as flags for the benchmark reference point south (RPS) reference point west (RPW) is shown in Appendix A.

Sands Survey was contacted in June of 2009 and stated that the pin that was used as the KDID benchmark in this survey was placed on site by Sands sometime in the early 1990's. They stated that they could not readily find the referenced data for that exact pin and stated that a local easting and northing coordinate system was used with no elevation and no true latitude/longitude datum. Lacking a datum or location, the pin was used for the KDID benchmark mainly because it was already in place and was readily accessible. It is to be noted that by using this pin it would be possible to convert the Sands Survey easting and northing coordinates to a latitude/longitude locations and turn all of the local pins to true latitude and longitude reference pins if desired.

A photograph of the pin and its general location are shown in Figure 3 and Figure 4 below.

Figure 3 KDID Benchmark/Sands Survey Pin

Figure 4 General Location KDID Benchmark/Sands Survey Pin

Once the KDID benchmark and the benchmark reference points were established, the elevation data was transferred to each of the pertinent features on the impoundment dam. Elevations were established for each of the piezometers, the dam crest, box culvert invert, emergency spillway invert and each of the drain inverts.

A Sokkia B21 level with± 0.01 ft. accuracy and a fiberglass survey grade rod with a ± 0.01 ft. accuracy was used to transfer the elevations to the site. The elevation survey was broken up into four separate surveys over six different days; KSI reference pin to the Mill Pond reference point, the Mill Pond reference point to the KDID benchmark, the KDID benchmark to piezometer 'P' on the crest of the dam, and from piezometer 'P' to the spillways, piezometers and drains.

Elevations from the KSI reference pin to the Mill Pond reference point were transferred to the individual turning points shown on the survey route using three-wire leveling. Individual turning points from the highway to the KDID benchmark were selected as the survey progressed. Individual points typically consisted of a nail driven in the ground or in the pavement. Some of the turning points were taken on pertinent features such as culverts telephone poles, etc. as noted in the field book. Survey data was triple checked in the field to assure errors were detected and elevations were calculated at each location. As the terrain from the highway to the Mill Pond was steep, and as survey work was conducted over two days during times truck traffic was on the road, in order to save several extra days of surveying a level loop to close the elevation survey from the Mill Pond reference point back to the KSI reference pins was not conducted. It is felt that using three-wire leveling and triple checking each shot preserved at least a ±0.05 ft. accuracy from the highway to the Mill Pond reference point.

Elevations from the Mill Pond to the KDID benchmark were transferred using three-wire leveling and a series of closed level loops. Level loops were closed to within ±0.01 ft. Elevations from the KDID benchmark to piezometer 'P' on the crest of the dam were transferred using a series of short level loop surveys closing within ±0.01 ft. Elevations from piezometer 'P' on the crest of the dam to the individual features were shot with a series of short level loops. Elevations from piezometer 'P' to the each of the piezometers & drain pipes was preserved with, at least, a ±0.05 ft. accuracy. The accuracy of the piezometer and drains was affected by the steep slope of the embankment but it was felt that the accuracy reported is valid. Copies of all field notes used to develop the elevations are provided in Appendix B to this report.

The latitude/longitude location data was transferred to the KDID benchmark using a Leica TC307 Total Station. The Leica TC307 has a 7-second (7") angle accuracy within a 2500 meter (8,200 ft.) single prism range. The only latitude/longitude location data that was transferred to the site with the Leica TC307 Total Station was the coordinates of the KDID benchmark and the benchmark reference pins to the south and west. All other latitude/longitude coordinates were transferred to box culvert, emergency spillway, drains and piezometers using a Garmin GPS 76CSx.

The Garmin 76CSx GPS is a WAAS[1] enabled GPS with a latitude/longitude location accuracy of 5 meters (16 ft.) or better. In order to improve accuracy as much as possible, the GPS latitude/longitude location and elevation datum was calibrated and reset at the KDID benchmark. The latitude/longitude location was then transferred to the pertinent features by allowing the GPS to rest at each location for at least 10 minutes or until the latitude/longitude location data was not changing and then the data was recorded as a waypoint in the GPS unit and then transferred to the field book. None the less, the latitude/longitude location accuracy of the pertinent features is significantly less than that reported for the KDID benchmark.

A table showing all of the elevations and latitude/longitude locations determined in this survey is provided in Appendix C to this report.

RESULTS

Corrections were made to the Mechanical and Structural Data in Table 1 in the Standard Operating Procedures of the Kootenai Development Impoundment Dam Operation and Maintenance Manual. The part of Table 1 that was corrected by this survey is shown below with the corrections made in bold and parenthesis next to the data previously reported. The changes reflected the new elevation and the total amount of change.

KDID Standard Operating Procedures Table 1:

Mechanical and Structural Data:

KEY ELEVATIONS	**ALL ELEVATIONS ARE NAVD 88 DATUM**
Crest of Dam	2,926 ft. **(2927.56 ft. MSL NAVD 88 +1.56ft.)**
Invert of Box Culvert	2,897 ft. **(2,897.52 + 0.52ft.)**
Invert of Emergency Spillway	2,922 ft. **(2,922.80 + 0.80ft.)**
Toe of Dam at A8	**2,792.70 ft.**
Rainy Creek Invert at the confluence of the toe drains flow	2,791 ft. **(2,789.5 ft. - 1.50ft.)**
MAIN DAM DIMENSIONS	
Structural Height	**135 feet (134.86 ft. - .14 ft.)**

Of the corrections made, the main difference is the elevation of the dam crest. All previous references were to a crest of 2,926 ft. MSL elevation. We have determined that the crest is actually 1.56 ft. higher than reported and is actually at 2,927.56ft. It is interesting to note that the elevation of the box culvert and the emergency spillway that was previously reported only changed by 0.52 and 0.08 ft. respectively. The total structural height was within 0.14 ft. of that previously reported.

Previous elevations used in the analysis of piezometers and drains were assumed elevations taken from the planned cross section of the KDID from the September 1981 Phase 1 Inspection report that were corrected by barometric

[1] Wide Area Augmentation System

elevations taken with the Garmin GPS 76CSx. Using the data in this survey we have improved the elevation for each of the piezometers and have also included the toe drains inverts used in the records. The elevations for each of the piezometers and drain inverts are now accurate to ±0.05 ft in NGVD 88 datum. Static water surface in the piezometers can now be correlated to the elevation of the dam crest and reservoir levels to within at least a ± 0.05 ft. accuracy.

CONCLUSION

We recommend that all of the elevation and latitude/longitude location data should be updated in the Operation and Maintenance Manual for the KDID. We recommend that a copy of this report and a table of the data changes be sent to the Montana Dam Safety Program.

In the event that future work is planned for the impoundment area, the embankment dam, or other areas on the site where accurate latitude/longitude location data is needed, it is recommended that a request is made to Sands Survey to provide the on site survey data. The easting and northing datum used by Sands can then be converted to latitude and longitude.

The crest of the dam is 1.56 ft. higher than previously reported but the net difference between the crest and the box culvert invert and the emergency spillway invert is 0.52 ft. and 0.08 ft. respectively. The theoretical capacity of the box culvert and the theoretical capacity of the emergency spillway will increase above that previously reported due to the increase in available head. As the capacity of the box culvert and the capacity of the emergency spillway far exceed the required capacity, we do not find a need to reassess the hydraulics of these structures at this time.

We note that the increase in crest height does not necessarily mean that there is an increase in reservoir capacity as the base elevation and capacity of the reservoir was not previously known within a ± 2 ft. range. Therefore it is not certain if the dam breach characteristics will change but it is not suspected that it will. We recommend that the breach data be reevaluated before the next 5-year operational permit renewal deadline.

APPENDIX A

NGS BENCHMARK DATA SHEET

KSI SURVEY REFERENCE DATA

SURVEY ROUTE MAP IMAGE

KDID BENCHMARK LOCATION IMAGE

The NGS Data Sheet

See file dsdata.txt for more information about the datasheet.

```
DATABASE =  ,PROGRAM = datasheet, VERSION = 7.80
1        National Geodetic Survey,   Retrieval Date = JANUARY 18, 2010
 TN0688 ***********************************************************************
 TN0688  DESIGNATION -  J 506
 TN0688  PID         -  TN0688
 TN0688  STATE/COUNTY-  MT/LINCOLN
 TN0688  USGS QUAD   -  VERMICULITE MOUNTAIN (1983)
 TN0688
 TN0688                          *CURRENT SURVEY CONTROL
 TN0688
 TN0688* NAD 83(1986)-  48 24 05.     (N)    115 27 03.     (W)     SCALED
 TN0688* NAVD 88     -       642.110  (meters)    2106.66   (feet)  ADJUSTED
 TN0688
 TN0688  GEOID HEIGHT-         -16.09  (meters)                     GEOID09
 TN0688  DYNAMIC HT  -         642.151 (meters)    2106.79   (feet)  COMP
 TN0688  MODELED GRAV-     980,655.1   (mgal)                       NAVD 88
 TN0688
 TN0688  VERT ORDER  -  FIRST     CLASS II
 TN0688
 TN0688.The horizontal coordinates were scaled from a topographic map and have
 TN0688.an estimated accuracy of +/- 6 seconds.
 TN0688
 TN0688.The orthometric height was determined by differential leveling
 TN0688.and adjusted in June 1991.
 TN0688
 TN0688.The geoid height was determined by GEOID09.
 TN0688
 TN0688.The dynamic height is computed by dividing the NAVD 88
 TN0688.geopotential number by the normal gravity value computed on the
 TN0688.Geodetic Reference System of 1980 (GRS 80) ellipsoid at 45
 TN0688.degrees latitude (g = 980.6199 gals.).
 TN0688
 TN0688.The modeled gravity was interpolated from observed gravity values.
 TN0688
 TN0688;                    North         East     Units  Estimated Accuracy
 TN0688;SPC MT       -   478,040.      159,930.      MT  (+/- 180 meters Scaled)
 TN0688
 TN0688                          SUPERSEDED SURVEY CONTROL
 TN0688
 TN0688.No superseded survey control is available for this station.
 TN0688
 TN0688_U.S. NATIONAL GRID SPATIAL ADDRESS: 11UPP146620(NAD 83)
 TN0688_MARKER: I = METAL ROD
 TN0688_SETTING: 49 = STAINLESS STEEL ROD W/O SLEEVE (10 FT.+)
 TN0688_SP_SET: STAINLESS STEEL ROD
 TN0688_STAMPING: J 506 1980
 TN0688_PROJECTION: FLUSH
 TN0688_STABILITY: B = PROBABLY HOLD POSITION/ELEVATION WELL
 TN0688_ROD/PIPE-DEPTH: 3.8  meters
 TN0688
 TN0688  HISTORY     - Date     Condition        Report By
 TN0688  HISTORY     - 1980     MONUMENTED       NGS
 TN0688
 TN0688                          STATION DESCRIPTION
```

TN0688
TN0688'DESCRIBED BY NATIONAL GEODETIC SURVEY 1980
TN0688'10.2 KM NE FROM LIBBY.
TN0688'10.2 KILOMETERS (6.35 MILES) NORTHEAST ALONG STATE HIGHWAY 37 FROM
TN0688'THE JUNCTION OF US HIGHWAY 2 IN LIBBY, AT THE T JUNCTION OF A
TN0688'PAVED ROAD LEADING EAST, 19.5 METERS (64.0 FEET) EAST OF THE CENTERLIN
TN0688'OF THE HIGHWAY, 17.7 METERS (58.0 FEET) NORTH OF THE CENTERLINE OF THE
TN0688'PAVED ROAD, 3.2 METER (10.5 FEET) NORTH OF A WOODEN SIGN READING -EM
TN0688'KAYAN VILLAGE-, ON THE EXTENDED CENTERLINE OF A 30 INCH DIAMETER CONCR
TN0688'PIPE CULVERT UNDER THE HIGHWAY.
TN0688'THE MARK IS 0.6 METERS S FROM A WITNESS POST.
TN0688'THE MARK IS ABOVE LEVEL WITH THE HIGHWAY.

*** retrieval complete.
Elapsed Time = 00:00:00

NGS BENCHMARK VIEWER

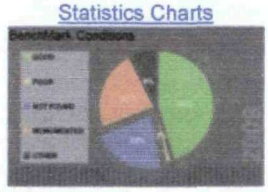
Not Affiliated with NGS

Benchmarking Index | Scaredy Cat Films Home Page | National Geodetic Survey Web Site

Montana **State Benchmark Viewer** - *Version 1.6*

Map Options

Statistics Charts

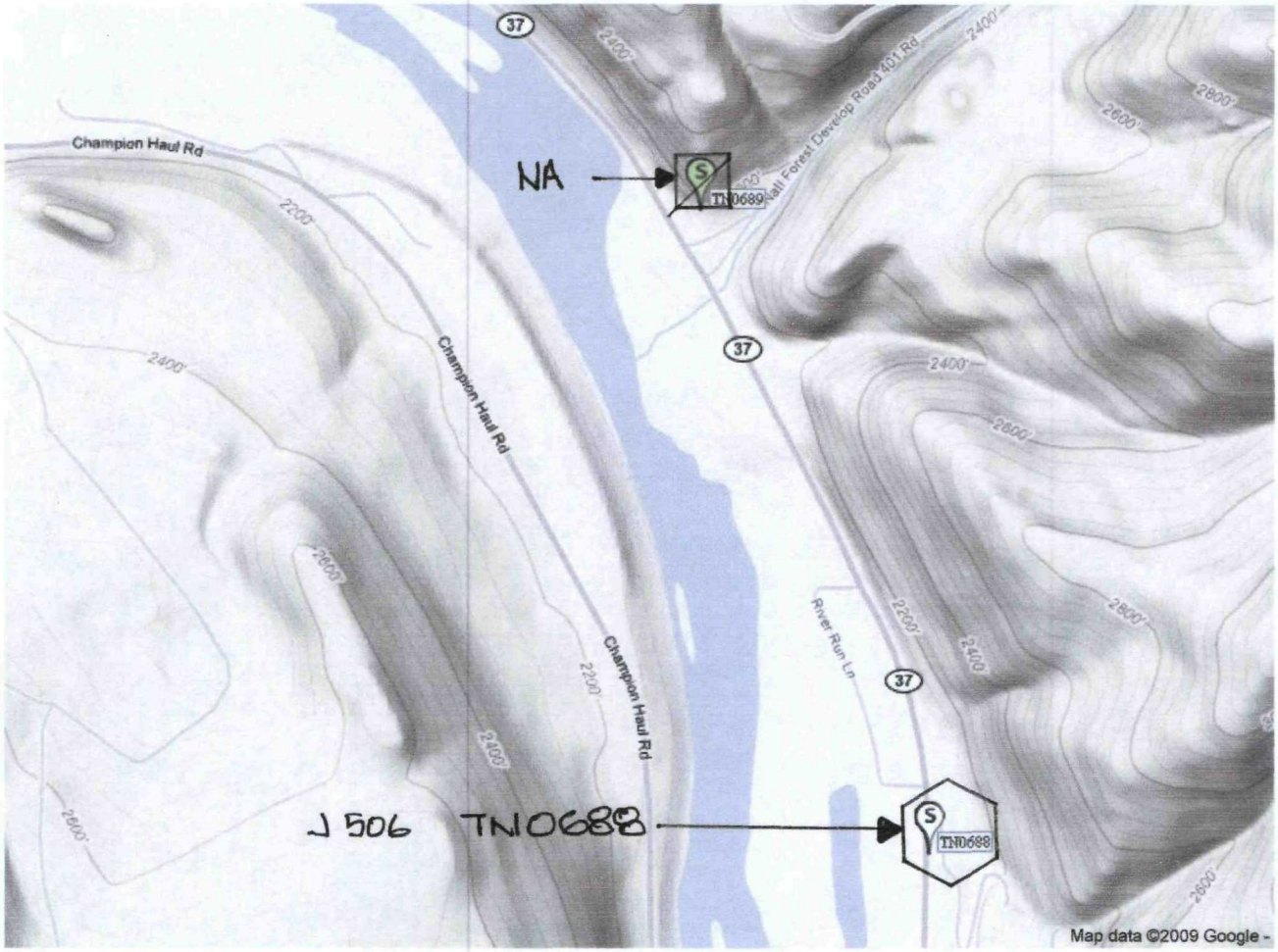


Location Search: Libby

Go! ☐ Use Small Icons ☑ Display Markers

It is Unlawful to Damage Marks!

Benchmark Map



DATA SHEET VIEWER

Submit

Clear

Gen LOC

Topo maps provided by MyTopo.com

There are 2 Benchmarks available for viewing at this zoom level.

Show LOC Text Area

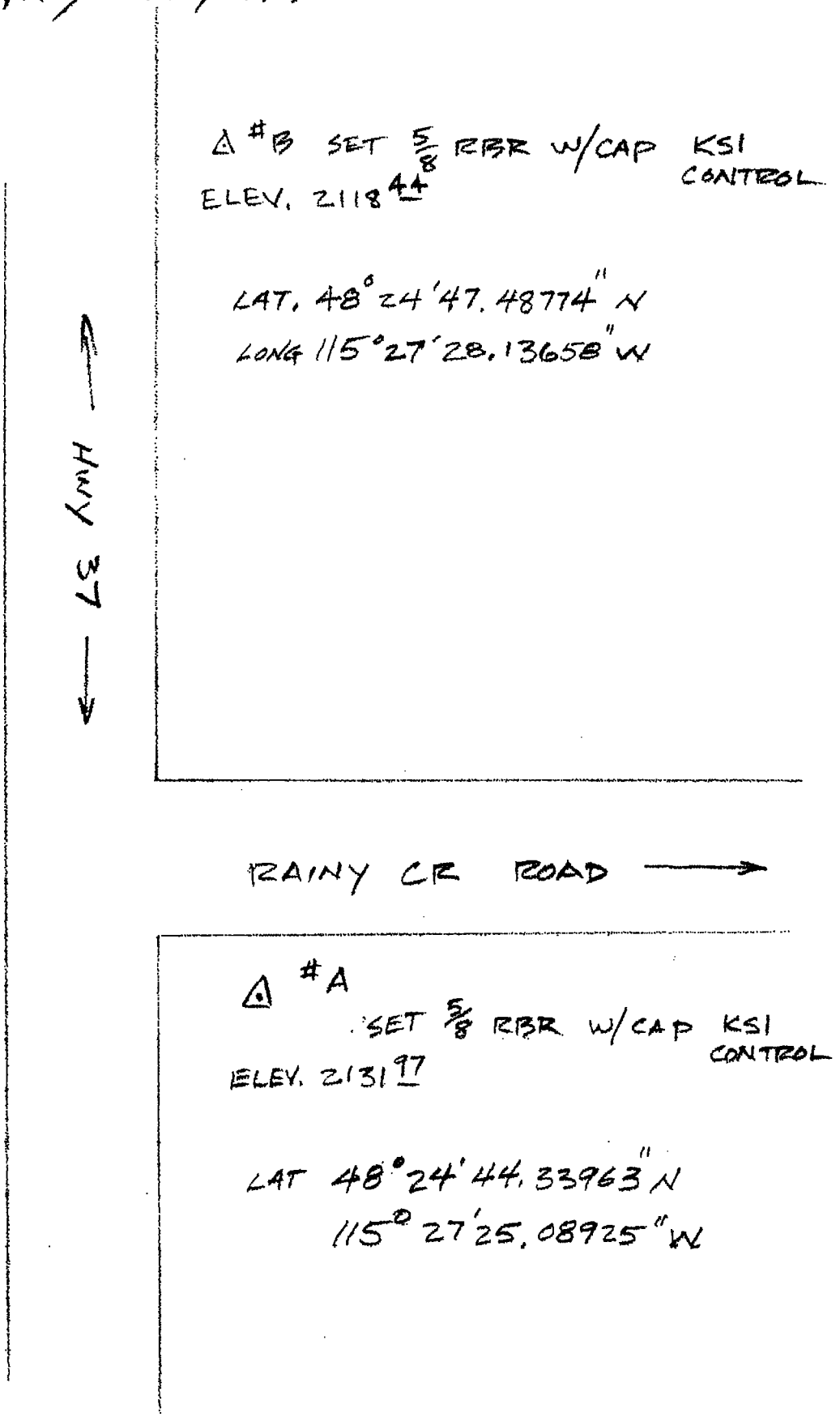
Major Cities

Major Cities: Billings, Helena

Statistics Charts

4-13-2009

BILL MAYER / RAINY CR.



REVISIONS	BY
DATE: 1/18/2010	GOOGLE EARTH IMAGE PASTE AND FORMAT

DRAWN BY: APPROVED BY: KMH

ELEVATION AND LOCATION SURVEY ROUTE

FOR

KOOTENAI DEVELOPMENT IMPOUNDMENT DAM

SECTIONS 15,21,22,28,29,and 32 in T.31 N., R. 30 W., P.M., LINCOLN COUNTY, MONTANA

BILLMAYER & HAFFERMAN,
3191 THIRD AVE. ENC. KALISPELL, MT.
59901 PHONE: (406) 257-8708
FAX: (406) 257-8710
EMAIL: info@billmayer.com
ONLINE: http://www.billmayer.com

DRAWING TYLE
GOOGLE EARTH IMAGE
KDID LOCATION AND ELEVATION SURVEY
TURNING POINT LOCATIONS
2005 COLOR AERIAL

SCALE: NTS

DATE: JANUARY 18,2010

PROJECT NO: R.56.1

DRAWING NUMBER:

1 OF 2

REVISIONS | DATE: 1/18/2010 | GOOGLE EARTH IMAGE PASTE AND FORMAT | BY

DRAWN BY: | APPROVED BY: KMH

KDID BENCHMARK AND REFERENCE PIN LOCATIONS

FOR

KOOTENAI DEVELOPMENT IMPOUNDMENT DAM

SECTIONS 15,21,22,28,29 and 32 in T.31 N., R. 30 W., P.M., M., LINCOLN COUNTY, MONTANA

BILLMAYER & HAFFERMAN, INC.
2191 THIRD AVE. EN, KALISPELL, MT. 59901 PHONE: (406) 257-8708
FAX: (406) 257-8710
EMAIL: info@billmayer.com
ONLINE: http://www.billmayer.com

DRAWING TITLE:
GOOGLE EARTH IMAGE
KDID BENCHMARK AND REFERENCE PIN LOCATIONS
2005 COLOR AERIAL

SCALE: NTS

DATE:	PROJECT NO:
JANUARY 18, 2010	R.56.1

DRAWING NUMBER:

2 OF 2

APPENDIX B

SURVEY FIELD NOTES

Tuesday May 5th, 2009
cloudy cool x 54° F
T Mallernan
J. Robertson

T near gate
PTA Loop

PT.	Lo	Mid	Hi	Avg	Elev.	HI
KSI/control KSI Control A	16.160	16.870	17.580	16.870	2131.91	2198.84
FSA,	1.691	1.939	2.187	1.939	2146.90	
35 FSA,	11.115	11.549	11.990	11.551	2137.29	
BM@gate	5.618	5.769	5.919	5.769	2143.07	

PTB Loop

FSB,		0.703			2130.527
PTB	11.951	12.789	13.630	12.790	2118.44
BS FSB,		0.707			2130.53

1. Work plan
- survey BM to gate
- read lower Thurne
- check beaver activity
- drains
- piezometers
- reservoir level

DRC - Thurne

- survey BM to dam up road

LRC-06 @ may - 1.250

2131.23
Move on

2131.234

5/5/2009 Heffernan: Robertson

wave gum

BS FSB,	7.112	7.361	7.612	7.362	2130.527
FS PTA	5.649	5.925	6.202		2131.964

kh - Done

Δ close = 2131.964 - 2131.97

Δ = -0.006 -key

BM set @ Gate is = 2143.070

Flow Monitoring

CC-2 - 0.475 Ft.
2137.889 Flow clear to shut brown

LRC-02 Behind mill pond

GH - 1.550
minor loss on left side & SgP log in the flume blocking flow rework log
GH - 1.280

ISCO Sample 3265 gpm - 1.482 Ft.

34

Location Level Loop Survey Date 5-19-09

Project / Client Bench Mark Survey Remediation

				Avg	Elevation
BS gate		21.78			
FS1	1.020 (Moved gun between shots)	1.220	1.442	1.227	2163.623
BS FS1	12.77	13.245	13.725	13.247	2163.623
FS2	–	0.173	0.965	0.173	2176.696
BS FS2	17.998	18.570	19.160	18.573	2176.696
FS3	1.192	1.390	1.588	1.390	2193.879
BS FS3	14.855	15.405	15.950	15.403	2193.879
FS4	0.809	0.995	1.182	0.995	2208.287
BS FS4	18.360	19.140	19.870	19.130	2208.287
FS 5	1.170	1.401	1.638	1.403	2226.014
BS FS5	10.062	10.508	10.951	10.507	2226.014
BM6	7.482	7.745	8.009	7.745	2228.776

35

Location Date

Project / Client

HI

BM @ gate = 2143.07

2164.850

2176.869

2195.263

2209.282

2227.417
↑ across from RT ramp

BM 6 set pin @ telephone pole midway between pole and edge of pavement

2236.521 ∧
2ft from

36

Location _____ Date 5-19-2009

Project / Client _____

	Lo	Mid	High	Avg	
FS7	0.500	0.910	1.321	0.910	2235.611
BS FS7	9.038	9.332	9.632	9.334	2235.611
FS8	0.850	1.072	1.297	1.073	2243.872
BS FS8	14.871	15.362	15.860	15.364	2243.872
FS9	0.190	0.395	0.598	0.394	2258.842
BS FS9	13.618	14.070	14.580	14.073	2258.842
FS10	0.489	0.729	0.972	0.730	2272.184
BS FS10	15.115	15.721	15.325	15.220	2272.184
FS11	0.595	0.838	1.061	0.831	2286.574
BS FS11	16.500	17.112	17.740	17.117	2286.574
FS 12	0.111	0.312	0.523	0.315	2303.376

Location _____ Date 5-19-2009 37

Project / Client _____

HI

2244.945

2259.236

FS9 downhill of second old telephone pole (guy)

2272.914

2287.405

2303.691

Location _____ Date 5-19-2009

Project / Client _____

STA	Lo	M.d	Hi	Avg.	Elev.
BSFS12	17.750	18.390	19.050	18.397	2303.376
FS 13	0.138	0.330	0.526	0.331	2321.441
BSFS13	17.625	18.250	18.840	18.238	2321.441
FS 14	0.482	0.690	0.900	0.691	2338.989
BSFS 14	17.645	18.325	19.025	18.332	2338.989
FS 15	0.300	0.510	0.726	0.512	2356.808
BSFS15	17.710	18.550	19.390	18.550	2356.808
FS16	0.389	0.675	0.962	0.675	2374.683
BSFS16	12.882	13.505	14.129	13.505	2374.683
FS 17	0.289	0.600	0.910	0.600	2387.589
BSFS17	13.90	14.589	15.280	14.590	2387.589
BMC8	11.650	12.115	12.580	12.115	2390.063

Location _____ Date 5-19-2009

Project / Client _____

HI
2321.772
2339.679
2357.320
2375.358
2388.188
2402.178

Location _____ Date 5-19-2009

Project / Client _____

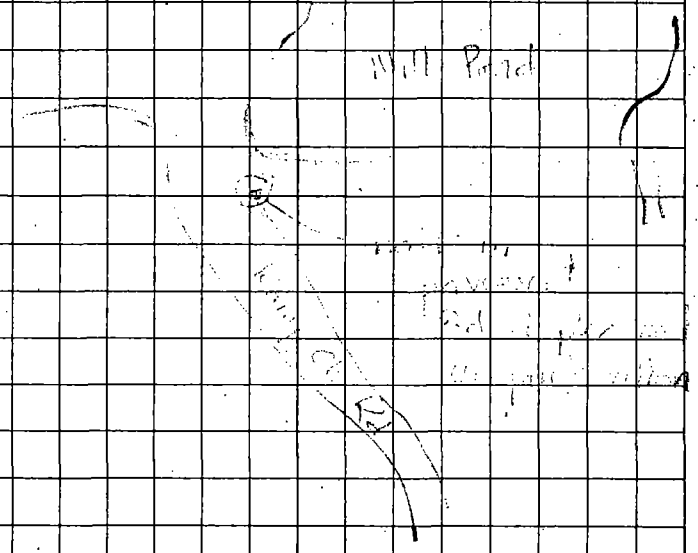
FS 18	0.142	0.392	0.642	0.392	2401.786
BS FS 18	12.720	13.300	13.880	13.300	2401.786
FS 19	0.721	0.975	1.227	0.974	2414.112

Location _____ Date _____

Project / Client _____

2415.086

Nail 1ft off edge of pavement
End of dam
Mid way up Ramp CL
Road.



Elevation Survey 5/27/2009
On Site @ 8:30 a.m.
Heffernan & Robertson

ARBITRARY STA	ACTUAL STA	Lo	Mid	Hi	Avg.	Elev.	HI
							2428.831
BS FS40	FS19	14.062	14.720	15.375	14.719	2414.112	FS40 arbitrary. (Actual number from survey of 5-19-09 is FS19)
FS41		1.592	1.790	1.990	1.791	2427.040	
BS FS41		20.851	21.950	23.040	21.947	2427.040	2448.987
FS42		0.200	0.448	0.692	0.447	2448.540	
BS FS42		20.255	21.535	22.790	21.527	2448.540	2470.067 GUN ON OPPOSITE SIDE OF ROAD.
FS43		0.169	0.379	0.588	0.379	2469.688	
BS FS43		20.295	21.400	22.515	21.403	2469.688	2491.092 GUN ON OPP. SIDE OF ROAD (West)
FS44		1.368	1.572	1.778	1.573	2489.519	
BS FS44		22.221	23.357	24.470	23.348	2489.519	2512.867
FS45		0.292	0.542	0.792	0.542	2512.325	
BS FS45		22.050	23.205	24.365	23.207	2512.325	2535.532

5/27/2009

		Lo	Mid	Hi	Avg	Elev	HI	
FS 46		1.230	1.430	1.631	1.430	2534.102	set nail 3.75 ft east of cap	
BSFS 46		15.789	16.555	17.331	16.558	2534.102	BS to nail	
							2550.660	
FS 47		0.643	0.860	1.075	0.859	2549.801		
BSFS 47		15.575	17.360	19.145	17.360	2549.801	2567.161	
FS 48		0.240	0.465	0.698	0.468	2566.693	42 ft. south of 1.0 mile	
BS FS48		16.620	17.745	18.862	17.742	2566.693	2584.436	
FS 49		0.080	0.510	0.940	0.510	2583.926		
BS 49		13.255	14.551	15.855	14.554	2583.926	2598.479	
FS 50		0.351	0.801	1.252	0.801	2597.678	30 ft north of telephone pedestal	
							on west side of road	
BSFS50		18.755	19.950	21.150	19.952	2597.678	2617.630	
FS 51		0.320	0.720	1.122	0.721	2616.909	gun on west side of road	
BS FS51		10.315	11.190	12.065	11.190	2616.909	2628.099	

5-27-2009

STA	Lo	mid	Hi	Avg.	Elev.	HI
FS52	0.302	0.808	1.312	0.807	2627.292	
BSFS52	8.73	10.010	11.300	10.013	2627.292 ✱	2637.305
FS53	0.130	0.760	1.390	0.760	2636.545	
BSFS53	9.710	10.690	11.670	10.690	2636.545	2647.235
FS54	4.135	5.135	6.140	5.137	2642.980	n ℄ of Rainy Ch culvert
BSFS54	6.558	7.512	8.470	7.513	2642.098	east side of road top of pavement. 2649.612
FS55	0.920	1.870	2.830	1.873	2647.738	
BSFS55	10.680	12.025	13.360	12.022	2647.738	2659.760
FS56	0.398	1.240	2.080	1.239	2658.521	
BSFS56	8.105	9.012	9.915	9.011	2658.521	2667.531
FS57	0.231	0.772	1.315	0.773	2666.759	
BSFS57	9.770	10.765	11.765	10.767	2666.759	2677.525

5-27-2009

STA.	Lo.	Mid	Hi	Avg.	Elev	HI
FS 58	0.454	1.031	1.615	1.033	2676.492	
BS FS 58	10.655	11.550	12.442	11.549	2676.492	2688.041
FS 59	0.166	0.660	1.162	0.663	2687.378	
BS FS 59	10.848	11.934	13.015	11.932	2687.378	2699.311
FS 60	0.510	1.075	1.648	1.078	2698.233	
BS FS 60	10.100	10.921	11.735	10.919	2698.233	2709.152
FS 61	0.248	0.718	1.188	0.718	2708.434	
BS FS 61	10.770	11.558	12.350	11.559	2708.434	2719.993
FS 62	1.150	1.532	1.919	1.534	2718.459	
BS FS 62	11.062	11.951	12.842	11.952	2718.459	2730.411
FS 63	0.310	0.775	1.242	0.776	2729.635	
BS FS 63	5.099	6.100	7.103	6.101	2729.635	2735.736

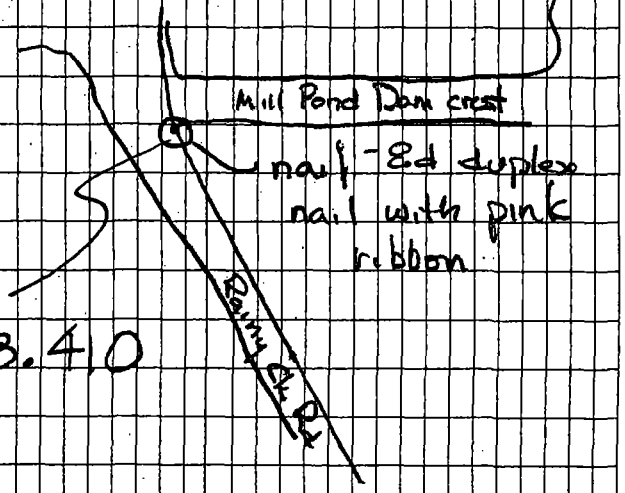
5-27-2009

FS 64	4.530	5.189	5.840	5.186	2730.550
BS FS 64	1.970	3.050	4.130	3.050	2733.600
FS 65	2.645	2.942	3.240	2.942	2730.657
BJ FS 65	9.270	9.830	10.390	9.830	2730.657
FS nail	1.740	2.078	2.415	2.078	2738.410

next to M.P. 2.0
2733.600

2740.487

Nail in pavement @ cl station
edge of mill crest

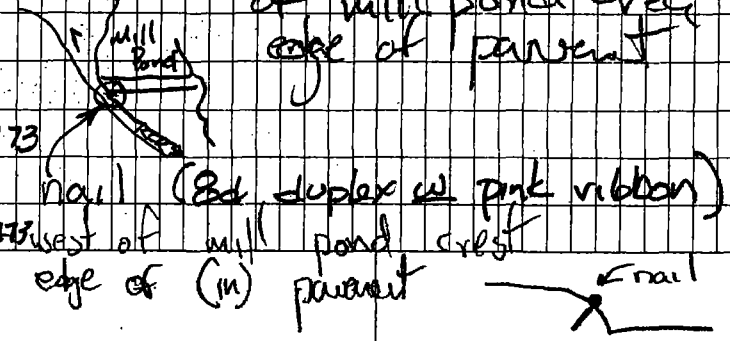


Continuing Survey above 5/4/2009
Mill pond

	Low	mid	high	Avg	Elev.	HI
BS_{5-4}	2.915	3.290	3.670	3.292	2750.423	2753.715
$FS1_{5-4}$	7.225	8.165	9.125	8.165	2745.550	
		close loop				
BS_{5-4}		3.290	Δ=0.000	close	2750.423	
		moved gun				
BS $FS1_{5-4}$						
	2.959	3.780	4.608	3.782	2745.550	2749.332
$FS2_{5-4}$	6.508	7.475	8.448	7.477	2741.855	
		close loop				
BS $FS1_{5-4}$		3.782	Δ=0.002	close	2745.550	
		move gun				
BS $FS2_{5-4}$	1.868	2.320	2.765	2.318	2741.855	2744.173
$FS3_{5-4}$	5.420	5.765	6.105	5.763	2738.410	2744.173
BS $FS2_{5-4}$		2.322	Δ=0.002	close		

≈ 100ft south of gate

$FS2_{5-4}$ = Northwest side of mill pond creek edge of pavement



5/4/2009

Survey (cont) from 4-24-2009

STA	+/- half prism	Elev	HI
BS FS$_3$	4.860	2927.101	2931.961
FS$_{crest}$	9.16	2922.801	
FS4$_A$	22.23	2909.731	
BS FS$_3$	4.855	2927.106	Δ = 0.005 close
BS FS4$_A$	1.590	2909.731	2911.321
ES5$_A$	23.97	2887.351	
BS FS5$_A$	0.624	2887.351	2887.975
ES6$_A$	19.150	2868.825	
Move gun BS ES6$_A$	0.520	2868.825	2869.345

gun on left side of emer spillway @ crest level

crest of emergency spillway high point ⊙ pin ½" nail w green flag

gate ⊙ end of emerg. spillway

½

STA		ROD		ELEV.	HI
FS7$_A$		20.025		2849.320	
		move gun			
BS FS7$_A$		1.778		2849.320	2851.098
FS8$_A$		15.69		2835.408	
BS FS8$_A$		1.310		2835.408	2836.718
FS9$_A$		19.140		2817.578	
BS FS9$_A$		1.692		2817.578	2819.270
FS10$_A$		15.910		2803.360	
BS FS10$_A$		1.040		2803.360	2804.400
FS11$_A$		23.52		2780.880	
BS FS11$_A$		2.522		2780.880	2783.402
FS12$_A$		22.290		2761.112	
BS FS12$_A$		0.101		2761.112	2761.213
FS13$_A$		10.79		2750.423	

5-4-2009 3/2

CURVE TABLES LRC-06

HOW TO USE CURVE TABLES 1.21

Table I. contains Tangents and Externals to a 1° curve. Tan. and Ext. to any other radius may be found nearly enough, by dividing the Tan. or Ext. opposite the given Central Angle by the given degree of curve.

To find Deg. of Curve, having the Central Angle and Tangent: Divide Tan. opposite the given Central Angle by the given Tangent.

To find Deg. of Curve, having the Central Angle and External: Divide Ext. opposite the given Central Angle by the given External.

To find Nat. Tan. and Nat. Ex. Sec. for any angle by Table I.: Tan. or Ext. of twice the given angle divided by the radius of a 1° curve will be the Nat. Tan. or Nat. Ex. Sec.

EXAMPLE

Wanted a Curve with an Ext. of about 12 ft. Angle of Intersection or I. P. = 23° 20′ to the R. at Station 542+72.

Ext. in Tab. I opposite 23° 20′ = 120.87
120.87 ÷ 12 = 10.07. Say a 10° Curve.

Tan. in Tab. I opp. 23° 20′ = 1183.1
1183.1 ÷ 10 = 118.31.

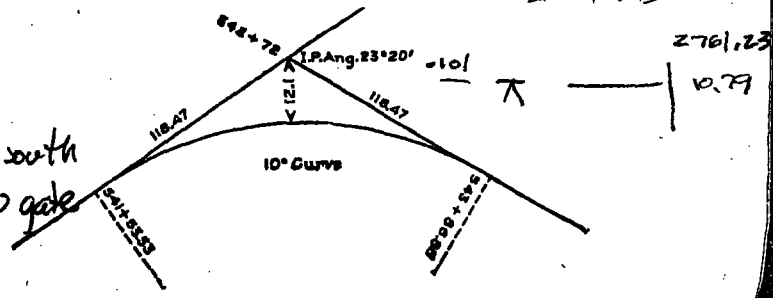
Correction for A. 23° 20′ for a 10° Cur. = 0.16
118.31 + 0.16 = 118.47 = corrected Tangent.

(If corrected Ext. is required find in same way)
Ang. 23° 20′ = 23.33° ÷ 10 = 2.3333 = L. C.

2° 19½′ = def. for sta.	542	I. P. = sta.	542+72
4° 49½′ = " " "	+50	Tan. =	1 .18.47
7° 19½′ = " " "	543	B. C. = sta.	541+53.53
9° 49½′ = " " "	+50	L. C. =	2 .33.33
11° 40′ = " " "	543+		
	86.86	E. C. = Sta.	543+86.86

100 − 53.53 = 46.47 × 3′ (def. for 1 ft. of 10° Cur.) = 139.41′ = 2° 19½′ = def. for sta. 542.
Def. for 50 ft. = 2° 30′ for a 10° Curve.
Def. for 36.86 ft. = 1° 50½′ for a 10° Curve.

2761.213



2761.23
10.79

100 ft. south of low gate

Level loop 4-24-2009

Haffermann & BROSSMAN

clear - cool

		Rod		
Sands		12.35	~~2906.776~~ 2906.771	2919.126
@ W.S.		16.96	2902.166	
F.S.1		3.64	2915.486	
Sands		12.36	~~2906.766~~ 2906.771	
	move gun			
BS. FS1		5.16	2915.486	2920.646
FS2		5.38	2915.266	
BS FS1		5.155	2915.491	close @ 0.005 ok ✓
	move gun			

W.S. @ 0.25 on rod
WS elev = 2902.416

close = 0.01 divide error

4-24-2009

STA		ROD		Elev	HI	
BS	FS2	12.145		2915.266	2927.411	
	FS 3	0.310		2927.101		
BS	FS2	12.145		2915.266	close @	0.00
		move gun				
BS	FS3	5.85		2927.101	2932.951	
	P	3.745		2929.206		
	P1	12.15		2920.801		
BS	FS3	5.85		2927.101	close @	0.00
Gain w CIV						
	URC-02		1.59			
IRC06-@M137-			1.33			

RT. side of dam upstream @ P.C.

top of casing $GS_P = P - 1.61$

$GS_P = 2927.556$

$GS_{P_1} = P_1 - 3.31 = 2917.491$

Piezometer Survey 4/30/2009

	set gun		Elev.		HI.
BS FS_3	–	6.060	2927.101		2933.161
FS_4	–	6.38	2926.781	ABOVE	P2
	move gun				
BS FS_4	–	5.20	2926.781		2931.981
P2.	–	11.44	2920.541		
P3.	–	10.77	2921.211		
P4	–	10.95	2921.031		
B5.	–	9.67	2922.311		
BS FS_3		~~4.88~~	2927.101		
FS_5		17.02	2914.961		
	Move gun				
BS FS_5		1.83	2914.961		2916.791
FS_6		15.71	2901.081		

4-30-2009 1/5

P- 1.61

P1 - 3.31

P2 3.22

↑ top of casing P2 gs = 2917.321

3.55 ags $gs_{P3\,elev} = 2917.661$

~~3.4~~ 2.7 $gs_{P4} = 2918.331$

~~3.4~~ 3.7 $gs_{P5} = 2918.611$

↑ DNSTM FACE ABOVE LIFT 4

4-30-2009

STN		Elev.	H.I.
move gun			
BS ~~FS~~ 6	4.825	2901.081	2905.906
PM2 4th lift ℄	2.570	2903.336	
PM 6 4th lift left groin	6.250	2899.656	
FS 7	17.360	2888.546	
move gun			
BS FS 7	1.750	2888.546	2890.296
PM 5 left gr lift 3	17.825	2872.471	
move gun			
BS PM5	4.762	2872.471	2877.233
FS 8	19.250	2857.983	

0.7 ags

GS_{PM2} = 2902.636

0.55 ags 2899.106

top of tree stump between lift 4 & lift 3

0.70 ags G.S. = 2871.771

between lift 3 and lift 2

4-30-2009

STA		ROD		ELEV.	H.I.
BS FS$_g$		2.92		2857.983	2860.903
PM 4 left grain 2nd lift.		17.051		2843.852	
	move gun				
BS PM 4 left grain 2nd lift		6.232		2843.852	2850.084
PM 3 & 2nd lift		4.280		2845.804	
PM 1 rt side of & 2nd lift.		3.682		2846.402	
FS$_g$		22.19		2827.894	
	move gon				
BS FS$_g$		1.660		2827.894	2829.554

0.60 ags = 2843.252

0.60 ags qs_{PM4} = 2843.252

0.70 ags qs_{PM3} = 2845.104

0.55 ags qs_{PM1} = 2845.852

between lft 2 and lft 1

4-30-2009. 4/4

ST.	ROD	INVERT	ELEV.	H.I.
FS_{10}	14.425		2815.129	
move gun				
$BSFS_{10}$	5.155		2815.129	2820.284
FS_{11}	17.119		2803.165	
$BSFS_{11}$	2.075		2803.165	2805.240
$FS\ A_8$	10.130		2795.110	
BS A8	2.485		2795.110	2797.595
D1	4.99	2791.605	2792.605	
D2	6.420	2790.175	2791.175	
D3	6.485	2790.277	2791.110	
D4	8.180	2788.748	2789.915	
D5	7.642	2789.953	2789.953	
D6	8.410	2788.102	2789.185	

A8 - 2.41 ags gs_{A8} = 2792.700

top of pipe

top

top

top

top

top

STA		ROD	Elev. Invert	ELEV.	HI
BS D6	–	1.809		2789.185	2790.994
D7		0.285	2789.876	2790.709	
D8		3.440	2786.721	2787.554	
D9		2.818	2787.343	2788.176	
D10		3.238	2786.756	2787.756	
D11		2.540	2787.621	2788.454	
BS D11		8.990		2788.454	2797.444
D12		7.300	2789.417	2790.144	

D1 - 12" CMP

D2 - 12" CMP

D3 - 10" RCP

D4 - 8" ~~CMP~~ RCP

D5 - 12" CMP

D6 - 13" ID STEEL

D7 - 10" RCP

D8 - 10" CMP

D9 - 10" RCP

D10 - 12" CMP

D11 - 10" RCP (9¾" ID)

D12 - 8" RCP (7⅝" ID)

APPENDIX C

SURVEY ELEVATION AND LATITUDE/LONGITUDE LOCATION DATA TABLE

ELEVATION SURVEY DATA			*KOOTENAI DEVELOPMENT IMPOUNDMENT DAM*			
DATE OF SURVEY APRIL - MAY 2009			*KURT HAFFERMAN, P.E.*			
ELEVATION DATUM: NAD 1983 DATUM			*BILLMAYER & HAFFERMAN INC.*			
SITE NAME	**SUB SITE NAME**	**ELEVATION**	**COMMENT**	**DISTANCE BELOW CREST**	**LAT. (N)**	**LONG. (W)**
KSI A		2131.97	At entrance at highway, east side	795.63	*48° 24' 44.33963"*	*115° 27' 25.08925"*
KSI B		2118.44	At entrance at highway, west side	809.16	48° 24' 47.48774	115° 27' 28.13658"
KDID BENCHMARK		2906.77	Sands Survey 1/2" Rebar with Cap	20.829	48° 26' 44.5412"	115° 25' 27.29815"
KDID RPS		2912.00	GPS Elevation	BM Reference point south	48° 26' 41.631"	115° 25' 29.656"
KDID RPW		2928.00	GPS elevation	BM reference point west	48° 26' 45.162"	115° 25' 28.466"
DAM CREST		2927.60	At piezometer P base	0	48° 26' 34.071"	115° 25' 35.640"
TOE OF EMBANKMENT		2792.70	A piezometer A8 base	134.900	48° 26' 28.500"	115° 25' 33.300"
PIEZOMETERS						
	PO				48° 26' 36.000"	115° 25' 31.200"
	P	2929.21	G.S. = 2927.556	-1.606	48° 26' 34.071"	115° 25' 35.640"
	P1	2920.80	G.S. = 2917.491	6.799	48° 26' 33.300"	115° 25' 33.120"
	P2	2920.54	G.S. = 2917.321	7.059	48° 26' 31.440"	115° 25' 29.520
	P3	2921.21	G.S. = 2917.661	6.389	48° 26' 31.200"	115° 25' 27.660"
	P4	2921.03	G.S. = 2918.331	6.569	48° 26' 30.480"	115° 25' 27.660"
	P5	2922.31	G.S. = 2918.611	5.289	48° 26' 29.460"	115° 25' 25.380"
	PM1	2846.41	G.S. = 2845.852	81.194	48° 26' 30.420"	115° 25' 33.960"
	PM2	2903.34	G.S. = 2902.636	24.264	48° 26' 31.020"	115° 25' 31.740"
	PM3	2845.80	G.S. = 2845.104	81.796	48° 26' 29.700"	115° 25' 32.580"
	PM4	2843.85	G.S. = 2843.252	83.748	48° 26' 28.320"	115° 25' 28.320"
	PM5	2872.47	G.S. = 2871.771	55.129	48° 26' 28.380"	115° 25' 28.620"
	PM6	2899.66	G.S. = 2899.106	27.944	48° 26' 28.440"	115° 25' 27.060"
	A8	2795.11	G.S. = 2792.700	132.49	48° 26' 28.500"	115° 25' 33.300"
DRAINS						
	D1	2792.61	INVERT = 2791.605 - 12" CMP	134.995	48° 26' 28.200"	115° 25' 33.060"
	D2	2791.18	INVERT = 2790.175 - 12" CMP	136.425	48° 26' 28.320"	115° 25' 33.060"
	D3	2791.11	INVERT = 2790.277- 10" RCP	136.49	48° 26' 28.680"	115° 25' 33.660"
	D4	2789.42	INVERT = 2788.748 - 8" RCP	138.185	48° 26' 28.680"	115° 25' 33.780"
	D5	2789.95	INVERT = 2789.953 - 12" CMP	137.647	48° 26' 28.860"	115° 25' 34.200"
	D6	2789.19	INVERT = 2788.102 - 13 " Steel	138.415	48 26' 28.510"	115° 25' 34.731"
	D7	2790.71	INVERT = 2789.876 - 10" RCP	136.891	48° 26' 28.800"	115° 25' 34.320"
	D8	2787.55	INVERT = 2786.721 - 10" CMP	140.046	48° 26' 28.860"	115° 25' 34.380"
	D9	2788.18	INVERT = 2787.343 - 10" RCP	139.424	48° 26' 29.160"	115° 25' 34.980"
	D10	2787.76	INVERT = 2786.756 - 12" CMP	139.844	48° 26' 29.520"	115° 25' 35.640"
	D11	2788.45	INVERT = 2787.621 - 10" RCP	139.146	48° 26' 29.520"	115° 25' 35.640"
	D12	2790.11	INVERT = 2789.477 - 8" RCP	137.486	48° 26' 30.240"	115° 25' 36.540"
BOX CULVERT		2900.10	INLET INVERT	27.5	48 26' 28.93"	115 25' 24.75"
		2904.10	INSIDE TOP OF CULVERT	23.5		
		2905.10	OUTSIDE TOP OF CULVERT	22.5		